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Study on Intestinal Parasitic Infections: Emphasis on Protozoan Parasites Entamoeba histolytica and Giardia lamblia and Associated Risk Factors Among School Children in Some Selected Primary Schools of Dembi Dolo Town, Western Ethiopia

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Abstract
Intestinal parasitic infections caused mainly by protozoa and are most prevalent in tropical and subtropical regions of the world where adequate water and proper sanitation are lacking. Children are greatly prone to these infections via the ingestion of food, water or soil contaminated with the infective stage of these parasites. The aim of this study is to assess the status of intestinal parasitic infections giving emphasis to protozoan parasites *Entamoeba histolytica* and *Giardia lamblia* and Associated Risk Factors among primary school children of Dembi Dolo town. The cross sectional study was conducted in Grade 1 to 4 children in some selected Government and private schools of Dembi Dolo town. Stool samples were collected in May 2019, from 384 children, both male and female of equal proportion. The specimens were processed and then examined microscopically to determine the presence of intestinal parasites. Multivariate logistic regression was used to predict association between infection rates with age, sex and school type. The quantitative data was analyzed using SPSS version 20.The difference was considered statistically significant at p-value=0.05. The intestinal parasitic infection rate for both protozoa and helminthes was 34.4%. Overall prevalence of intestinal protozoan infections among the school children was 18 %. *Entamoeba histolytica* infection was higher (13.3%) than *Giardia lamblia* (4.7%). The prevalence of protozoan infection was slightly higher in males (9.90%) than females (8.07%), but the difference was not significant. The protozoan infection was higher among children whose age is lower compared to the higher age groups. The parasitic infection rates were significantly higher in Berhana Yesus school (38.3%) compared to Burka Hayota (31.2%). Majority of the children 97.4% had single species infections while 2.6% had multiple protozoa and helminthes infections. The personal hygienic factors associated with intestinal parasitic infections were failure to boil drinking water and wash hands with soap before eating. In conclusion there is relatively high prevalence of intestinal protozoan infections among the studied children.Therfore, on personal hygiene and environmental sanitation health education should be adopted in primary schools in order to reduce intestinal parasitic infections among school children.
Keywords: Intestinal parasites, Prevalence, Risk factors, School children
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Introduction

Parasitic diseases continue to have a significant impact on the world's populations, especially in the lesser-developed regions of the world where delivery of health care, sanitation, and vector control efforts are less than adequate. However, the increased mobility of populations, immigration and development of populations due to civil strife are contributing factors that may extend their geographic range, or at the very least, create new public health concerns in previously unaffected areas (non-endemic areas). Both urbanization as well as movement in to suburban areas produces problems unique to both. Overcrowding in urban areas may test the adequacy of sanitation and control of the most common parasite species (WHO, 2011). Parasitic infections, and in particular those caused by protozoa, are a major public health problem. Intestinal parasitic infections are the most common infection worldwide. They are among the most widespread human infections in developing countries, with children being the most vulnerable population (Harhay, 2010). Parasites affect billion of people of all races and demographic regions. Intestinal parasitic infections are among the most common infections worldwide (Ukpai and Ugwu, 2003). Parasitic diseases represent a major cause of morbidity in most parts of the world (El –Masry *et al.*, 2007).

The human is a habitat of 399 species of parasites (Ashford and Crewe, 1998). Of these, 197 species are reported to live in the alimentary tract (Crompton, 1999). The prevalence of intestinal parasites is the highest among children that are living in the poorest communities in developing nations. The most common causes of intestinal parasites are through consumption of contaminated water, infected soil, inadequate sanitation and hygiene, and improper hygiene (Ziegelbauer, 2012). Protozoa are microscopic, one-celled organisms that can be free-living or parasitic in nature. They are able to multiply in humans, which contributes for their survival and also permits serious infections to develop from just a single organism. The human intestinal protozoa include nonpathogenic and pathogenic parasites (WHO, 2014). Based on the world health organization (WHO) reports,

approximately two-thirds of the world populations are infected with a wide range of parasitic protozoa. About 3.5 billion persons are infected with intestinal parasites and nearly 450 million suffer from clinical morbidity (WHO 2000). These reports also showed that, nearly 16 million of the total deaths occurring in developing countries are related to parasitic infections. According to earlier studies, children from developing countries, especially school age children, have the maximum rate of morbidity to intestinal parasites in comparison with other ages (Stephenson *et al*., 2000).

The protozoan parasites are the more common cause of gastrointestinal disorders compared to helminthes especially in developing countries. A number of intestinal protozoan parasites are reported in different parts of the world. Among them *Entamoeba histolytica* and *Giardia lamblia* are the major protozoan parasites of global health concern. Protozoan parasites being single celled can rapidly multiply inside the body leading to the development of the serious infection. Most of the protozoan infections tend to be asymptomatic. However, the common symptoms associated with it include abdominal discomfort, vomiting and dysentery. When burden of infection is pronounced, it may cause several complications like diarrhea, malaise, bloating, fatigue, epigastric discomfort, malnutrition, mal-absorption, intestinal ulceration, gastroenteritis, weight loss, abscesses, mental retardation, and even death. Protozoan infections can also lead to structural and functional abnormalities of small intestines in humans and can be misdiagnosed as appendicitis or other inflammatory diseases of gastrointestinal tract. Children are the primary victims of gastrointestinal protozoan parasites. So the disease control interventions need to be focused towards the pediatric group (Stephenson *et al*., 2000).

Poor access to safe water supply and hygiene are important risk factors for transmission of intestinal parasites. Primary school children frequently contact soil after and during school thus increasing chances of getting infected through ingestion of helminthes eggs and / or protozoa cysts due to poor personal hygiene. The children also involved in handling of food in homes hence if proper hygiene is not practiced they are likely to transmit infections to other people. Therefore, the study was initiated due lack of previous study in the area and inadequate water supply, poor hygiene among entire populations.

Materials and Methods

Study Area and period

The study was carried out in three primary schools within Dembi Dolo town of Western Ethiopia (Figure 1). Dembi Dolo is the capital of KelemWelega Zone of the Oromia Region. The town has a latitude and longitude of 8^{0}32N 34 48E/ 8.533^{0}N 34.800^{0}E with an elevation between1701 and 1827 meters above sea level. The town is characterized by moist midland, the annual rainfall 1670.65mm and the mean annual temperature is 19.45oC (Dembi Dolo town communication office).The town is bounded at four sides by Seyo Wereda. The 2007 national census reported a total population for this town of 29,448, of whom 15,144 were men and 14,304 were women. The majority of the inhabitants were Protestants, with 58.23% reporting that as their religion, while 30.14% observed Ethiopian Orthodox Christianity, 8.81% observed Islam, and 2.07 were catholic. The study was conducted from February 10 to August 30/2019.

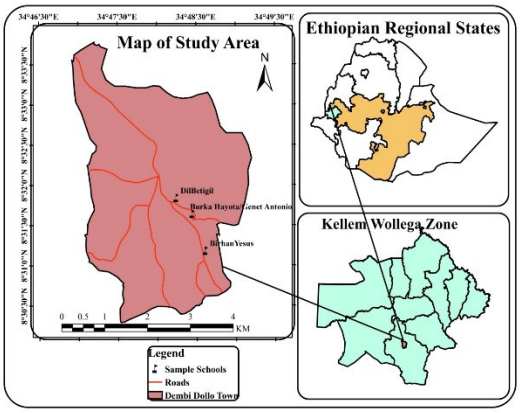

Figure I: Map of Study area (Source: Garmin 72 GPS)

Study Population

The study population were all school children whose age were 7-13 years who were attending their education at public schools and the sample population were the selected school children from the selected schools(Burka Hayota, Berhana Yesus and Dil Betigil primary schools) in Dembi Dollo town of western Ethiopia.

Study Design

This was a cross sectional descriptive study involving some selected primary school children in Dembi Dolo town.

Sample Size Determination and Sampling Technique

The sample size in this study was calculated by using single proportion formula at 95% confidence interval level (Z (1-α/2)=1.96) and 5% marginal error. Then, the sample size were calculated by using the formula n=[Z 1-a/2]2 p(1-p)/d2=384.

The number of children sampled in each class was then proportionately distributed among each of the four classes. In the class 35 children were selected from an average of 50 children per class. The selection was done from children present in class using the class register by allocating random numbers.

Stool Collection and Laboratory Examination Procedures

A total of 422 stool specimens were collected from both male and female of one, two and three children from the three primary schools. The children were given sterile, capped specimen bottles labeled with random numbers, and an applicator stick. They were instructed to collect a first morning stool specimen. Stool specimen for each of the classes were collected on three consecutive days per week beginning from Grade one to Grade Four. The stool specimens from the school were examined usining Direct wet mounts to observe the presence or absence of protozoa cysts and / or trophozoites according to laboratory practice (Cheesebrough, 2001) at Dambi Dolo Hospital by two qualified laboratory technicians. Randomly picked stool specimen were re-examined by a third technician to increase the accuracy of results.

Data Collection

Data on the occurrence of intestinal parasitic infections among children was obtained by laboratory investigations of the collected stool specimen. Data on personal hygiene, social demographic and environmental factors was collected using predesigned questionnaires. The questionnaires were prepared in two languages (English and Afan Oromo). The questionnaires was filled by children one day before collection of stool specimen after which they are given specimen sterile specimen bottles to bring stool specimen the following morning. A check list on the environmental sanitation in school was filled by boarding masters, who are teachers in the respective schools. The stool specimens were collected as described below. The questionnaires contained three sections; the first section was on social demographic factors such as age, class, residence, the second section was on environmental factors including water source, type of toilets, presence of flies in toilet and / or latrines, and the last section was on hygiene practices such as washing hands, fruits and other food items. Some samples of the questionnaires were pretested on two children randomly selected from each of the four classes of the school.

Data Analysis

The quantitative data was coded and entered into a computer data base designed using SPSS version 20 and data cleaning and validation were performed in order to achieve a clean dataset by the software. The rates of intestinal parasitic infections among the school children based on their sex and age was analyzed by expressing the positive samples as a percentage of the total number of children sampled. The data was compared using multi variant regression and Analysis of Variance (ANOVA) to predict whether there is significant association. Adjusted odds ratio (AOR) was used to determine the association of environmental and personal hygiene practices and intestinal parasitic infections. Binary logistic regression was conducted at $p<0.2$ and the potential variables were entered in to multivariable logistic regression. The difference was considered significant at a $p<0.05$. Quantitative data was presented using tables and graphs.

Treatment

Children' participation in the study was fully voluntary and confidentiality was maintained during the study. The procedure was non-invasive hence not harmful to the subjects. Positive cases for any intestinal parasite were treated according to FMHACA, Standard Treatment Guidelines for General Hospital, 3rd Edition, 2014.

Ethical clearance/considerations

The study was approved by the graduate school, Wollega University. The ethical clearance was obtained from the Research Ethics Review Committee (RERC) of Wollega University. Written informed consent was obtained from each guardian for individuals below 18 years old. Further, no loss or harm came to the study participants of this study. In addition confidentiality of data and information from this study was maintained.

Results

Socio demographic factors

Out of 384 children, 192(50%) were males and 192(50%) females. Majority, 131(34.1%) were 7-8 years old followed by 129(33.6%) and 124(32.3%) in the age groups 9-10 and 11-13 respectively. Concerning their residence, 319(83.1%) were from Dembi Dolo town and 65(16.9%) from surrounding rural areas (Table 1)

Table 1: Socio-demographic data and rate of infection with intestinal parasite (n=384)

Sex		Grade level				Age in year			Infection rate, n(%)
		1	2	3	4	7-8	9-10	11-13	
M	192	43	43	43	43	66	65	61	72(37.50%)
F	192	43	43	43	43	65	64	63	60(31.25%)
T	384	96	96	96	96	131	129	124	132(34.4%)

Occurrence of Intestinal Infections among Children

Out of the total 422 children recruited at the start of the study, only 384 among them provided stool specimen for three consecutive weeks. They also completed all the information required on the questionnaires. Of these children, 50% were males and another 50% were females. The intestinal parasitic infection rate for both protozoa and helminthes was 34.4%. The infections due to protozoa were 18% and 16.4% were due to helminthes, while multiple infections were 2.6%.

The types of intestinal parasitic infections found in the sampled children were *Entamoeba histolytica/dispar, Giardia lamblia, Ascaris lumbricoides, Hymenolepsis nana* and hookworms. Among the protozoan infections *Entamoeba histolytica/dispar* had the highest infection rate (13.3%). *Ascaris lumbricoides* had the highest infection rate (9.90%) among the helminthes (Figure 2).

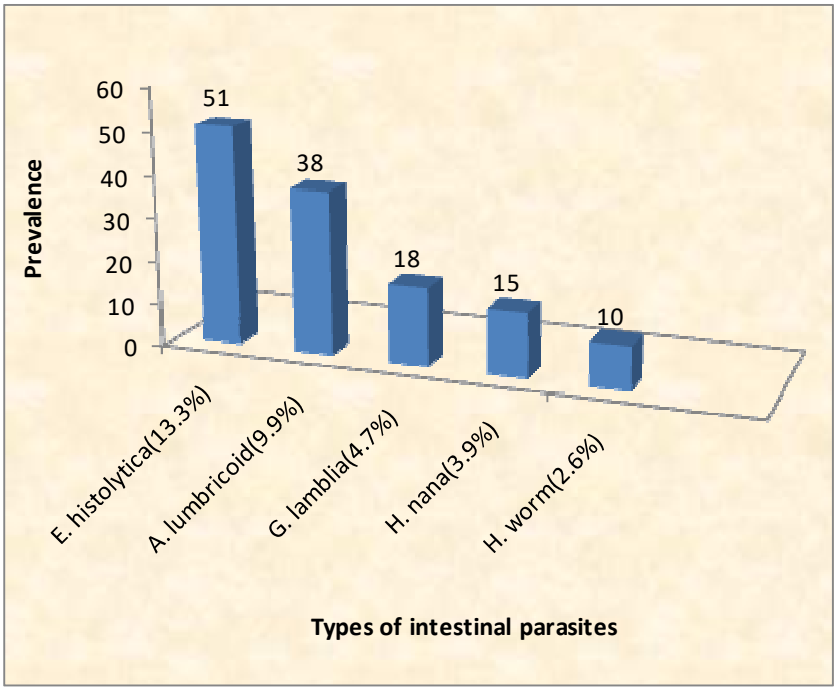

Figure 2: Infection rates of Intestinal Parasites among the studied children

There were variations in intestinal parasitic infections with respect to age in the studied children. Children of 7-8 years age group recorded highest prevalence of pathogenic intestinal parasites whiles children within the age group 11-13 years recorded the lowest. Among the pathogenic intestinal parasites, it was observed that prevalence decreases with advancement in age (Figure 3).

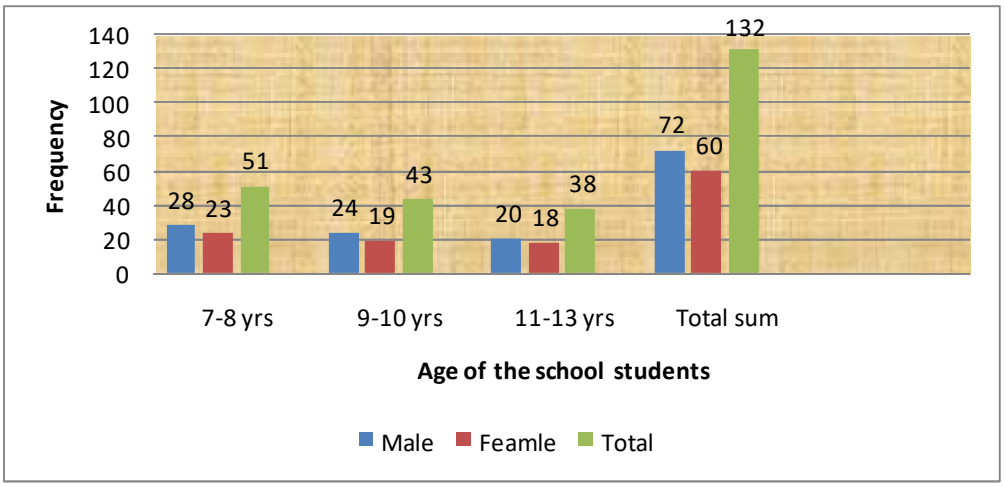

Figure3: Age distribution of Intestinal Parasites among the studied children

Five intestinal parasites were identified in the study: two protozoans and three helminthes species. The commonest intestinal parasites associated with the children were *Entamoeba histolytica*, followed by *Ascaris lumbricoid* while hook worm was the least. The most common protozoa in all the schools, *Entamoeba histolytica/dispar* was (13.3%), and there was significant difference in the infection rates due to protozoa infections among the different schools (Table 3). *Ascaris lumbricoides* infections were the most common among the helminthes in all the schools sampled at 9.90% while Hook worm was the least at 2.6% (Table 2).

Table 2: Infection rates of various species of intestinal parasites per school

Parasites	Schools			Total infections n=384; n(%)	COR	CI	p-value
	Burka Hayota n=128; n(%)	BerhanaYesus n=128; n(%)	Dil Betigil n=128; n(%)				
E.histolytica	15(11.72%)	18(14.1%)	18(14.1%)	51(13.3%)	1.02	1.15-1.25	0.00
G.lamblia	7(5.5%)	5(3.91%)	6(4.7%)	18(4.7%)	2.05	1.02-3.10	0.005
Total protozoa	22(17.2%)	23(17.97%)	24(18.75%)	69(18%)	2.01	1.91-2.03	0.00
A. lumbricoids	10(7.81%)	16(12.5%)	12(9.4%)	38(9.9%)	1.09	1.11-1.53	0.02
Hook worm	3(2.34%)	4(3.12%)	3(2.34%)	10(2.6%)	2.70	1.03-5.09	0.705
H.nana	5(3.91%)	6(4.7%)	4(3.12%)	15(3.91%)	3.01	1.00-4.04	0.004
Total helminthes	18(14.1%)	26(20.31%)	19(14.84%)	63(16.41%)	1.92	0.81-2.35	0.003
Total parasites	40(31.25%)	49(38.28%)	43(33.59%)	132(34.4%)	1.50	0.99-2.0	0.01

Comparing infection rates by intestinal protozoa and helminthes among different groups, it was shown that infection rates were highest among group one (7-8years of age) children (38.93%) followed by group two (9-10 years of age) children (33.33%) while group three (11-13 years of age) children had the least at (30.65%) in all the three schools combined (Table 3). There were variations in intestinal protozoan infections with respect to age in the studied children. Children of 7-8 years age group recorded highest prevalence of pathogenic intestinal protozoan infection whiles children within the age group 11-13 years recorded the lowest. Hence, it was observed that prevalence decreases with advancement in age.

Table 3: Infection rates of protozoa and helminthes among different age groups

Group	School			Total n=384; n(%)	P-value
	Burka Hayota n=128; n(%)	Berhana Yesus n=128; n(%)	Dil Betigil n=128; n(%)		
7-8 yrs of age n=131(group 1)	16(12.2%)	20(15.3%)	15(11.45%)	51(38.93%)	P=0.001
9-10 yrs of age n=129 (group 2)	14(10.85%)	16(12.4%)	13(10.1%)	43(33.33%)	P=0.055
11-13yrs of age n=124 (group 3)	10(7.75%)	13(10.1%)	15(11.63%)	38(30.65%)	P=0.093
Total	40(10.42%)	49(12.76%)	43(11.2%)	132(34.4%)	P=0.99

Out of 384 children, 192(50%) were males and 192(50%) females. Majority, 131(34.1%) were 7-8 years old followed by 129(33.6%) and 124(32.3%) in the age groups 9-10 and 11-13 respectively. Concerning their residence, 319(83.1%) were from Dembi Dolo town and 65(16.9%) from surrounding rural areas. To quantify the relationship between the infection rate, highest age, grade 4 and females was used as the reference test respectively.The statistical analyses demonstrated significant differences between microscopy and concentration method (P = 0.04). Concentration method revealed by far the highest positivity rate (9.4%) compared to the microscopic methods. To quantify the relationship between the techniques, microscopy was used as the reference test (Table 4).

Table 4: Multivariate logistic regression analysis of socio-demographic data in relation to intestinal protozoa/helminthes-positive, (n=384)

Variables	Alternatives	Number	+ve, n(%)	AOR	95% CI	P-value
	7-8	131	51(38.9%)	2.3	1.32-5.21	0.001
Age	9-10	129	43(33.3%)	1.9	1.12-2.50	0.02
	11-13	124	38(30.6%)	1	1	1
	M	192	72(37.5%)	2.03	1.88-4.31	0.03
Sex	F	192	60(31.3%)	1	1	1
	1	96	39(40.6%)	3.02	1.63-6.88	0.02
Grade	2	96	33(34.4%)	0.63	0.03-1.06	0.08
Level	3	96	32(33.3%)	0.35	0.01-1.65	0.06
	4	96	28(29.2%)	1	1	1
	Urban	319	111(28.5%)	1	1	1
Residence	Rural	65	21(5.7%)	2.01	-6.12 to -1.06	0.04
Methods	Microscopy	320	104(27.1%)	1	1	1
	Ether conc.	64	28(7.3%)	0.73	3.14-7.21	0.03

The male children had an overall infection rate of 37.50%, which was slightly higher compared to females at 31.3% (Table 5). Infection rate with both protozoa and helminthes were slightly higher in males than in females at 9.90% and 8.85% respectively for protozoa, and 8.07% and 7.55% respectively for helminthes. Most scholars have attributed this skewness to socio-cultural and behavioural differences between males and females children. Males obtained higher prevalence of intestinal parasitic infection because they get more freedom than females whose leisure hours are strictly controlled and restricted hence are less exposed to parasitic infections.

Table 5: Intestinal Parasitic Infections by sex (n=384)

Intestinal parasites	Males n=192 n (%)	Females n=192 n (%)	Total n(%)
E. histolytica	27(14.1%)	24(12.5%)	51(13.3%)
G. lamblia	11(5.7%)	7(3.65%)	18(4.7%)
Total protozoa	38(19.8%)	31(16.2%)	69(18%)
A. lumbricoids	21(10.9%)	17(8.85%)	38(9.9%)
Hook worms	5(2.6%)	5(2.6%)	10(2.6%)
H. nana	8(4.2%)	7(3.65%)	15(3.9%)
Total helminthes	34(17.7%)	29(15.1%)	63(16.4%)
Total Intestinal parasites	72(37.50%)	60(31.25%)	132(34.4%)

Co-Infection of Protozoa and Helminthes Intestinal among Children

Most of the infections among children were of single species. However, 2.6% of the children tested had multiple infections.The most common co-infections were recorded between *A. lumbricoides* and *E. histolytica/dispar* (0.78%). Berhana Yesus primary school had significantly higher co-infection rate of 1.30% compared to Dil Betigil school 0.78% and Burka Hayota at 0.52%. Co-infections of *A. lumbricoides* and *H. nana* were recorded only in Berhana Yesus school (Table 6).

Table 6: Co-infection rates of protozoa and helminthes among the three schools (n=384)

	Sample schools			
Intestinal parasites	Burka Hayota n(%)	Berhana Yesus n(%)	Dil Betigil n(%)	Total n(%)
A. lumbricoides and *E. histolytica*	1(0.26%)	3(0.78%)	2(0.52%)	6(1.56%)
A. lumbricoides and *H.nana*	0(0%)	1(0.26%)	0(0%)	1(0.26%)
E. histolytica and *H.nana*	1(0.26%)	1(0.26%)	1(0.26%)	3(0.78%)
Total co-infections	2(0.52%)	5(1.30%)	3(0.78%)	10(2.6%)

Intestinal parasites in relation to family background

The protozoan infection was higher among children whose parents were illiterates (41.54%) than among primary (45.0%) and secondary and above (28.0%) schools completed individuals (Table 7). Increased risk of infection was found in children who were their parents involved in farming activities compared to those not involved in farming activities.

Table 7: Socio- demographic factors of intestinal parasites in relation to family background (n=384)

Characteristics		Number of children, n(%)	Infected children, n(%)
Family size	Three to five	164(42.71%)	49(29.88%)
	More than five	220(57.29%)	83(37.73%)
Educational level	Illiterate	65(16.93%)	27(41.54%)
	Read and write	173(45.05%)	78(45.09%
	Secondary and above	146(38.02%)	41(28.08%)
Work	Employee	141(36.7%)	45(31.9%)
	Farmer	79(20.6%)	29(36.7%)
	Merchant	54(14.1%)	19(35.2%)
	Other	110(28.6%)	39(35.4%)

Transmission and Associated Risk factors in relation to Intestinal Parasitic Infections among Children

Concerning the risk factors of intestinal parasitic infections in relation to environmental sanitation within the homes majority of them used unimproved water sources (71.61%).Also, most of the children (78.65%) used pit latrines in homes as opposed to flush toilets. The study showed that 57.29% were infested with flies and / or cockroaches (Table 8).

Table 8: Transmission and Associated Risk factors in relation to home environment (n=384)

Environmental factors	Number of children n(%)	Infected children n(%)
Improved water sources	109(28.4%)	21(5.47%)
Unimproved water sources	275(71.6%)	111(28.9%)
Pit latrines	302(78.6%)	118(30.7%)
Flush latrines	82(21.3%)	14(17%)
Presence flies and/ or cockroaches in sanitary facilities	220(57.3%)	72(32.7%)
Absence of flies and /or cockroaches in sanitary facilities	164(42.7%)	60(36.5%)

All the three schools sampled obtained water from unimproved sources and did not have had hand washing facilities close to the latrines and dining facilities (Table 9).None of the three schools sampled provided children with soap for washing hand after visiting toilets or before meals. All the three schools sampled had pit latrines for the children. Children in all the schools cited seeing flies and cockroaches in the latrines and toilets.

Table 9: Environmental factors that influence transmission of intestinal parasites within the schools

		Schools		
Risk factors	Conditions	Burka Hayota	Berhana Yesus	Dil betigil
Water sources	Improved	×	×	×
	Unimproved	√	√	√
Provision of safe drinking water	Provide	×	×	×
	Don't provide	√	√	√
Provision of hand washing facilities	Provide	×	×	×
	Don't provide	√	√	√
Provision of soap	Provide	×	×	×
	Don't provide	√	√	√
Type of sanitary facilities	Pit latrines	√	√	√
	Flush toilets	×	×	×
Flies and / or cockroaches in sanitary facilities	Present	√	√	√
	Absence	×	×	×

Personal hygiene practices influences transmission of intestinal parasitic infections. The results showed that only 32.7% of the children boiled drinking water. Boiling drinking water was significantly associated with reduced likelihood of infection with intestinal parasites. A large number of children did not wash hand after visiting toilets or before meals. Of these, 66.06% were infected with intestinal parasites. The children who washed their hands with soap after visiting the toilets and before meals were less likely to be infected with intestinal parasites However washing hands with water only without soap did not significantly reduce infections with intestinal parasites.

About 27.5% of the children washed fruits before eating. This significantly reduced their chance of infection with

intestinal parasites .About 60% of the children eat food sold in open places, this practice was however not associated with infection with intestinal parasites (Table 10).

Table 10: Personal hygiene practices that influence transmission of intestinal parasites

Personal hygienic practices	Number of children	Children infected n(%)
Boiling drinking water	58	13(22%)
Not boiling drinking water	326	165(50.6%)
Washing hands after visiting toilets	219	95(43%)
Not washing hands after visiting toilets	165	109(66%)
Washing hands with soap	130	44(33.8%)
Not washing hands with soap	254	132(51.9%)
Washing fruits before eating	203	56(27.5%)
Not washing fruits before eating	181	83(45.8%)
Eating food sold in open places	175	105(60%)
Not eating food sold in open places	209	99(47%)
Sources of fruits & vegetables from market	186	69(37%)
Sources of fruits & vegetables from farm	198	107(54%)

Discussions

Most of the existing data on intestinal parasitic infections has been based on school age children of 14-20 years old. The current study accessed the occurrence of intestinal parasitic infections among school attending children aged between 7-13 years in three primary schools in Burka Hayota, Berhana Yesus and Dil Betigil in Dembi Dolo town. The overall infection rate for both protozoa and helminthes was 34.4%.

The total prevalence of protozoa in this study was 18% and that of helminthes were 16.4%. The types of intestinal parasitic infections found in the sampled children were protozoa; *Entamoeba histolytica/dispar* (13.3%) and *Giardia lamblia* (4.7%). In addition to *trichuris trichiura* the same intestinal parasites were identified by the research conducted in Addis Ababa (Mekonn *et al.,* 2014).

In Ethiopia this result (13.3%) was relatively higher when compared to the finding of Mojo health center, eastern Ethiopia (2%) in the year 2009 (Bayissa 2013). On the other hand, the rate was relatively goes in line when compared to the findings of study conducted at Tikur Anbesa hospital showed that *Entamoeba histolytica/dispar* was the most common reported parasite with 13.6% prevalence rate (Petri and Sing 1999) and was lower when compared with the study in semi-pastoralist tribes in lower Omo Valley, Southwestern Ethiopia by Teklehaymanot (2009) (16 %).

The rate of *Giardia lamblia* in this study (4.7%) was relatively similar (4.3%) regarding the result recorded in Awuramba, reported by Yihinew (2011), and 4.4% in Anambra state reported by Emmy-Egbi *et al*. (2012), but it was relatively lower than 4.9% in Gorgora and chuahit health center North Gondar reported by Abate *et al*. (2013), 6.6% in Teda Health center North Gondar, 6.7% in Babile town Eastern Ethiopia reported by Tadesse (2005) and 6.4% in Nigeria reported by Auta *et al*. (2013).

In this study, the prevalence of parasitic infection was seen slightly higher in males (37.5%) than females (31.3%) but the difference was not significant. Most scholars have attributed this skewness to socio-cultural and behavioural differences between males and females children.

A similar study conducted by Sah *et al.* (2013) in Dharan, Nepal which also showed higher infection rate of protozoa in males (14.3%) than females (11.4%). Other studies for example, done in Bondo District, Kenya among children aged between 5-20 years showed a higher infection rate in boys than in girls at 39.0% compared to 34.5%) (Thiongo, *et al*., 2009). Studies done in China indicated a higher infection rate 53% among the male children compared to 39% among female children aged between 10-23 years (Wang *et al*., 2012). On the contrary a study conducted by Alyousefi *et al.,*(2011) in Sana'a city, Yemen showed that the infection rate of protozoa was lower in males (29.4%) than females (32.2%).

In this study slightly higher levels of infection (38.98%) were recorded among Group one (7-8 years of age) student compared to those in Group two (9-10 years of age) and Group three (11-13 years of age) at 33.3% and 30.65% respectively. This could be because group one children are younger hence may have been exposed to variety of contaminated environments. According to WHO (2010), infection rates vary by age groups in which prevalence is higher in lower age groups. This result goes in line with studies done in Western Kenya that indicated a higher infection rate among children aged below ten years (47%) compared to those aged above ten years (30%) (Thiong'o *et al*., 2009).

When compared relatively the infection rate of the three schools, Berhana Yesus primary school had the highest infection rate (37.5%) compared to Dil Betigil (33.6%) and Burka Hayota (31.3%). This could be about 40% of the children of the Berhana Yesus primary school had come from villages. In the village, the source of water is stream which could be contaminated with faeces from wild animals. Additionally, the families are

involved in farming activities and there is a lack of appropriate food hygiene.

Multiple infections of protozoa and helminthes existed in only 2.6% of the children sampled. The highest co-infection rate recorded in this study was between *A. lumbricoides* and *E. histolytica/dispar* at 23.1% and higher co-infection were recorded relatively in male children.

The study showed that all the three schools sampled had pit latrines as opposed to flush toilets. Construction of toilets and proper usage has been suggested as an effective control measure of intestinal parasites. In circumstances where toilets are not easily cleaned and the water table is high protozoan infections may not be effectively controlled. The study reported presence of flies and /or cockroaches in pit latrine both at home and in school, indicating that they were not well maintained hygienically. These vectors potentially carry the protozoan cysts mechanically and deposited them on food leading to infections. They could also be a source of infection for the latrine users especially if they do not wash hands after latrine use.

The study indicates that 54.7% of children used unimproved water sources in their homes. These children were found to have higher protozoa infections than those using improved water sources. In addition all the schools sampled did not provide safe drinking water for the children. These factors could have lead to increase in transmission of intestinal parasites especially *Entamoeba histolytica/dispar* and *Giardia lamblia* that are commonly transmitted through fecal contamination of drinking water.The discrepancies between the present and other previous studies may be due to differences between studied population characteristics or geographical and socioeconomic factors, and prevailing climatic and social conditions in the areas of study.

Conclusions

The study revealed that the present prevalence of intestinal protozoan infection among primary school children aged 7 to 13 years in the Dembi Dolo town was 34.4%. *Entamoeba histolytica/dispar* was the commonest pathogenic protozoan in the studied children followed by *Giardia lamblia* recorded the second of protozoan parasite. The total occurrence of protozoa was 18% and helminthes infection rates were 16.4%. The most common protozoan infection was due to *E. histolytica/dispar* at 13.3% while *G. lamblia* infections was 4.7%. Most of the infections among children were single protozoa and helminthes species infections at 97.4% while multiple infections between helminthes-helminthes species and helminthes-protozoa were 2.6%.The highest co-infection rate was between *A. lumbricoides* and *E. histolytica* at 35.7%. The most important environmental factors predisposing children to intestinal parasitic infections were drinking unsafe water and lack of self hygiene. The personal hygiene factors predisposing children to infection with intestinal parasites were failure to boil drinking water, failure to wash hands with soap after visiting toilets and failure to wash fruits before eating. Most of the agents identified in the study exhibited decreasing prevalence with increasing age.This study concluded that there was high level of intestinal parasitic infections among the primary school children with associated transmission risks. It is recommended that health education on personal hygiene and environmental sanitation be adopted in primary schools in order to reduce intestinal parasitic infections among children. The public health sector should provide health education on environmental sanitation and personal hygiene practices and promote environmental sanitation in primary schools.

Competing interests

The authors declare that they have no competing interests regarding the publication of this manuscript.

Author's contributions

MD and AA conceptualized the idea and drafted the initial proposal. AA was finalized the study proposal. MD and AA were leading the development of the data collection tools. AA contributed to data processing and analysis. MD drafted the manuscript. Both authors read and approved the manuscript.

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